Scrap Tires in Ciudad Juárez and El Paso: Ranking the Risks

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Abstract

According to conventional wisdom, rapidly growing stocks of scrap tires on the U.S.–Mexico border pose a variety of health and environmental risks. This article assesses these risks in Paso del Norte, the border's second-largest metropolis comprised principally of Ciudad Juárez, Chihuahua, and El Paso, Texas. We find that air pollution from tire pile fires poses the greatest threat. Scrap tires in Paso del Norte do not contribute significantly to the propagation of mosquito-borne diseases or to shortages of space in solid waste disposal sites. The burning of scrap tires at industrial facilities is minimal and might not have significant adverse environmental impacts even if it were more common.

Key Words: Scrap tires, U.S.–Mexico border, environment, health, risk assessment

JEL Classification Numbers: Q2, O54

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1. Introduction

Over the past decade, explosive population growth and a steady demand for used American tires in Mexico have contributed to the proliferation of scrap tires on the U.S.–Mexico border.[1] Most of the major border cities host piles containing tens of thousands of tires, and a few of the largest cities—Tijuana, Ciudad Juárez, and Mexicali—are home to piles ten times as large (Blackman et al. 2001). Local and national stakeholders are becoming increasingly concerned about the attendant health and environmental risks. According to conventional wisdom, scrap tires constitute a fire hazard, generate acute air and water pollution when set ablaze, breed disease-carrying mosquitoes, provide dirty fuel for industrial facilities, and contribute to shortages of space in solid waste disposal sites. To mitigate such problems, local governments are developing projects aimed at shrinking stocks of scrap tires. Increasingly, they are turning to federal, state, and international authorities for assistance. For example, the Border Environmental Cooperation Commission, a binational organization that evaluates border infrastructure projects, has received four proposals related to scrap tires since June 1999, including one from Ciudad Juárez (BECC 2001).

Notwithstanding this growing concern, we still know relatively little about the health and environmental risks associated with scrap tires—information needed to inform mitigation

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[1] During the 1990s, annual population growth rates in border cities were well above the national averages for Mexico and the United States. On the Mexican side, the population grew by 53% in Ciudad Juárez, Chihuahua, 68% in Tijuana, Baja California, and 48% in Nogales, Sonora. On the American side, the population grew by 9% in El Paso, Texas, 44% in Laredo, Texas, and 41% in Brownsville, Texas (*Economist* 2001).

policies. What are the relevant risks? Which are paramount? The answers to such questions are not likely to apply universally: they depend, among other things, on local geography, climate, and demography.

Based on interviews with more than 40 local stakeholders as well as primary and secondary documents, this article assesses health and environmental risks associated with scrap tires in the second-largest urban center on the border: Paso del Norte, the metropolitan area comprised principally of Ciudad Juárez, Chihuahua and El Paso, Texas.[2] We focus on four types of risk: (1) the link between tire piles and mosquito-borne diseases, (2) the contribution of scrap tires to municipal solid waste disposal problems, (3) air and water pollution from tire pile fires, and (4) air pollution from the use of tires as fuel. Our analysis is preceded by a discussion of the generation, stocks, and end uses of scrap tires.

2. Generation, stocks, and end uses

U.S.-Mexico border

According to a widely used rule of thumb, the annual generation of scrap tires in the United States is equal to the country's population. Thus, Americans generate roughly 273 million scrap tires per year—by weight, approximately 2% of the country's annual output of solid waste. Unfortunately, consumption does not keep pace with generation: as of 2001, there were an estimated 300 million scrap tires in stockpiles throughout the United States (STMC 2002a).

On the U.S.–Mexico border, scrap tire disposal is a particularly challenging problem. Mexican demand for American used tires generates a steady flow of used tires from the United States into the border region.[3] Most of the cross-border trade in used tires is illegal and informal, since importing such tires into Mexican border states (except Baja California) is prohibited under Mexican law. Although official records show that the United States exported just under 840,000 used tires to Mexico between 1978 and 1985, by all accounts the real figure is much higher (ITA 2001; Reiter and Sprenger 1987). Most American used tires smuggled into Mexico originate outside the border region.

[2] Paso del Norte also includes Sunland Park, New Mexico. We confine our attention to Ciudad Juárez and El Paso because Sunland Park contains less than 1% of the metropolitan area's combined population (approximately 1,800,000), and because we have very few data specific to this city.

[3] American scrap tires are often used in Mexico until the tread is completely worn; they are then discarded.

Data on stocks of scrap tires in the border region are limited. To our knowledge, reliable studies have been conducted in just two cities: Ciudad Juárez and Mexicali (EcoTechnologías de Mexico 2001; Ramirez et al. 1999). However, interviews with a variety of stakeholders suggest that the tire piles in these two cities are the largest on the border.[4]

Paso del Norte

Using original survey data along with government figures on vehicle ownership, a 2001 consulting study concluded that Ciudad Juárez generates approximately 828,000 scrap tires per year, or 0.69 tires per person per year (EcoTechnologías de Mexico 2001). However, this estimate omits the flow of American used tires into Ciudad Juárez.

The largest tire pile in Ciudad Juárez is a secured monofill called the Centro de Acopio, located just south of the city. Originally an illegal tire dump, this site has been managed by the city since 1994. This site contains approximately 1,043,000 tires (EcoTechnologías de Mexico 2001).

In addition to Centro de Acopiothere are two large tire piles in Ciudad Juárez, each with over 10,000 tires, and quite a few smaller piles containing from a dozen to two thousand tires. Estimates of the number of tires in small piles dispersed throughout the city range from two to four million (Chacon 2001; Salmeron 2001).

El Paso City-County generates about 879,000 tires annually (TNRCC 2000). The city of El Paso's one official secured tire pile, Tres Pesetas, is a privately owned tire collection and transport facility. The site currently contains fewer than 5,000 tires. Although Tres Pesetas accepts almost 2,000 tires per day (730,000 tires a year), it immediately transports them to end users (Perry 2001). Little is known about smaller, informal scrap tires piles in El Paso.

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4 Matamoras, Tamaulipas, and Nogales, Sonora, probably have fewer than 100,000 scrap tires each, and Tijuana, Baja California, probably has fewer than 1 million tires. By contrast, secured and unsecured piles in Paso del Norte contain well over 1 million tires (Blackman et al. 2001). According to Chacon (2001), the scrap tire disposal problem in Ciudad Juárez is at least as bad as in any other Mexican border city, and it is worse than in the interior of Mexico.

End uses

In the United States, most scrap tires are no longer simply consigned to dumps. Rather, they are increasingly used as inputs into a variety of activities. The American market for scrap tires has grown dramatically over the past decade, from about 22% of total generation in 1990 to 72% of total generation in 2000 (Banipal and Mullins 2001). Tire-derived fuel (TDF) remains the most important end use for scrap tires in the United States, accounting for about two-thirds of the total market. TDF is principally used in cement kilns, electric utilities, and pulp and paper mills (Table 1).

Table 1. Estimated Scrap Tire Market in the USA (millions)

	1998	2000
Tire-Derived Fuel (TDF)	114	125
Cement kilns	38	--
Electric Utilities	25	--
Pulp/paper mills	20	--
Dedicated tires-to-energy facilities*	16	--
Industrial boilers	15	--
Civil Engineering	20	18
Ground Rubber Products	15	18
Cut and Stamped Products	8	8
Pyrolysis process	0	0
Misc./Agriculture	6	12
Export	15	15
Total End-uses	178	196
Total Generation	270	273

*Power plants using TDF exclusively

(Source: STMC 1999 and 2002a)

In Texas, 20.3 million scrap tires, representing 85% of total annual generation, were reused in some way in 2000. Table 2 shows the composition of the Texas scrap tire market. Again, TDF is the most significant end use.

Table 2. Composition of Market for Scrap Tires in Texas in 2000 (%)

Tire-Derived Fuel	46
Civil Engineering Projects	25
Landfilling (cut or shredded)	7
Septic Systems	6
Land Reclamation	4
Crumb Rubber	5
Other	7

(Source: Forehand 2001)

Of the scrap tires accepted by the Tres Pesetas facility in El Paso, the end use for more than two-thirds is a landfill reclamation project. The remaining tires are used in conjunction with septic tanks, to make toys, to cover piles of agricultural produce, and as TDF in a cement plant in Odessa, Texas (Perry 2001).

Although a small proportion of Ciudad Juárez's scrap tires is used for fuel by traditional brickmakers (see Section 6 below) and as building materials for informal housing, most are simply stockpiled. According to local stakeholders, however, other end uses are currently envisioned for the city's scrap tires, including TDF for cement kilns, rubberized asphalt, layering in landfills, rubberized flooring, and blended rubber (Higgs 2001; Chacon 2001; Figueroa 2001; Kelly 2001).

3. Mosquito-borne diseases

Scrap tires and mosquitoes

Scrap tire piles are ideal mosquito incubators.[5] They absorb heat and trap rainwater, leaf litter, and microorganisms—functions that promote the growth of mosquito larvae (CDC 2001b). As a result, tire piles can propagate mosquito-borne diseases. Trade in used tires infested with mosquito larvae has contributed significantly to the global dispersion of disease-carrying

[5] Rodents also breed in tires piles. However, this does not appear to be a significant problem in Paso del Norte, in part because scrap tires are separated from other solid wastes that attract rodents. There have been no reports of rodent bites in the Centro de Acopio tire pile since the city began managing it in 1994.

mosquitoes, most notably *Aedes Aegypti* and *Aedes Albopictus*, the two principal vectors of dengue virus.[6]

Tire piles are typically high-priority targets of efforts to prevent or slow outbreaks of mosquito-borne diseases. Unfortunately, treating them with insecticides is problematic. It is difficult to penetrate tire piles to the depths where mosquitoes breed. Also, mosquitoes are developing resistance to many widely used insecticides. Finally, insecticides used to suppress adult mosquitoes are environmentally hazardous, and those used to suppress larvae are costly. Thus, mitigating mosquito-borne diseases may require completely removing tire piles (URI 2001).

Mosquitoes and infectious disease

Mosquito-borne diseases include dengue, encephalitis, malaria, and yellow fever. According to Cortez-Flores (2001), globally, dengue is currently the most important of all vector-borne viral diseases in terms of human morbidity and mortality. Primarily a disease of the urban tropics, dengue can produce a spectrum of clinical illness, ranging from a nonspecific viral syndrome to severe and fatal hemorrhagic disease. People with classic dengue fever are often sick for three to four weeks. Although dengue fever is not usually fatal, dengue hemorrhagic fever (DHF) and dengue shock syndrome can be. On average, 5% of hospitalized cases result in death. The majority of fatalities occur among children younger than 15 years (CDC 2001c).[7]

Dengue is not uncommon on the U.S.–Mexico border. During a 1995 dengue outbreak, the city of Reynosa, Tamaulipas reported 2,706 cases and Matamoros, Tamaulipas reported 408 cases. In Reynosa, 1% of those infected developed DHF (CDC 1996). Data from the Pan American Health Organization (Table 3) make clear that dengue and DHF are prevalent in all the Mexican border states except Baja California and Chihuahua (where Ciudad Juárez is located). Dengue fever outbreaks can have serious economic impacts. For example, the cost of a 1981

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[6] The link between scrap tires and disease-carrying mosquitoes first came to light in 1940s, with the return to the United States of mosquito-infested surplus tires used in Asia during World War II. However, since the mid-1980s, when heavy infestations of *Aedes Albopictus* in southeastern Texas were traced to scrap tire piles, U.S. law has required all used tires imported from Asia to be certified as dry, clean, and insect-free (Reiter and Sprenger 1987; Reiter 1998).

[7] Infection with one of the four serotypes that cause dengue does not provide cross-protective immunity, so persons living in a dengue-endemic area can have four dengue infections during their lifetimes. Severe cases usually occur when victims are infected by two different serotypes simultaneously (CDC 2001c).

epidemic in Cuba with 344,203 reported cases was estimated at U.S. $103 million ($299 per case); the cost of a 1994 outbreak in Thailand involving 51,688 reported cases of DHF was estimated at $19.3 million ($689 per case) to $51.49 million ($572 per case) (Meltzer et al. 1998). In Texas, outbreaks negatively affect both short-term tourist visits and the migration of "winter Texans" to border communities (ICE 2001).

Table 3: Cases of Dengue/Dengue Hemorrhagic Fever in Mexican Border States

State	1995	1996	1997	1998	1999	2000
Chihuahua	25 / 0	1 / 1	NR / NR	NR / NR	NR / NR	NR / NR
Baja Ca. Norte	0 / 0	1 / 0	1 / NR	NR / NR	NR / NR	NR / NR
Sonora	NR / 1	1,331 / 20	112 / 1	33 / NR	413 / NR	211 / 2
Coahuila	NR / 5	357 / 7	113 / 5	30 / 1	905 / 5	3 / NR
Nuevo Leon	183 / 28	1,005 / 85	674 / 36	1,341 / 33	4,769 / 129	11,474 / 49
Tamaulipas	347 / 36	4,572 / 198	1,774 / 41	3,580 / 46	4,561 / /64	196 / 5

NR: no reported new cases

(Source: Pan American Health Organization 2001)

Aside from dengue, St. Louis encephalitis (SLE) and eastern equine encephalitis (EEE) have also received considerable attention on the U.S.–Mexico border. The disease severity for both SLE and EEE range from asymptomatic to fatal. Mild cases entail fever, headache, and sometimes viral meningitis; more serious cases involve stupor, coma, tremors, and convulsions. Infection can result in long-term neurological problems. Ten percent of the symptomatic SLE cases and 30% of symptomatic EEE cases are fatal (CDC 2001c).

During the past ten years, there have been SLE outbreaks in eastern Texas in 1990, 1991, 1992, 1993, and 1995. The number of SLE cases in each outbreak ranged from 7 to 42. Sporadic cases were reported in 1994, 1996, 1998, and 2000 (Vilchis 2001b).

Documented evidence and expert opinion suggest that although mosquito-borne diseases represent a serious problem in the eastern part of the U.S.–Mexico border, they do not currently pose a significant threat in Paso del Norte. Table 4 presents data on human cases of six mosquito-borne diseases in El Paso City-County. Clearly, dengue, yellow fever, and equine encephalitis are not a serious problem in the American section of Paso del Norte.[8] In fact, no mosquito-borne disease is currently a significant problem in El Paso (L. Ortega 2001; Leyva 2001; Provencio 2001; Vilchis 2001a).

Table 4. Human Cases of Mosquito-borne Diseases in El Paso City-County

Year	Saint Louis Encephalitis	Unspecified Encephalitis	Equine Encephalitis	Malaria	Dengue*	Yellow fever
1979	4	1	0	4	-	0
1980	0	2	0	1	-	0
1981	0	0	0	1	-	0
1982	2	0	0	0	-	0
1983	1	1	0	1	-	0
1984	1	1	0	0	-	0
1985	0	3	0	0	-	0
1986	0	3	0	0	-	0
1987	0	2	0	0	-	0
1988	1	0	0	1	-	0
1989	0	0	0	0	-	0
1990	0	0	0	2	-	0
1991	1	1	0	0	-	0
1992	0	2	0	0	-	0
1993	0	3	0	1	-	0
1994	0	4	0	5	-	0
1995	0	0	0	3	-	0
1996	0	0	0	2	-	0
1997	0	1	0	0	-	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	1	0
Total	*10*	*24*	*0*	*21*	*1*	*0*

*Incidence not reported prior to 1997.

(Source: El Paso City County Health and Environmental District, Epidemiology)

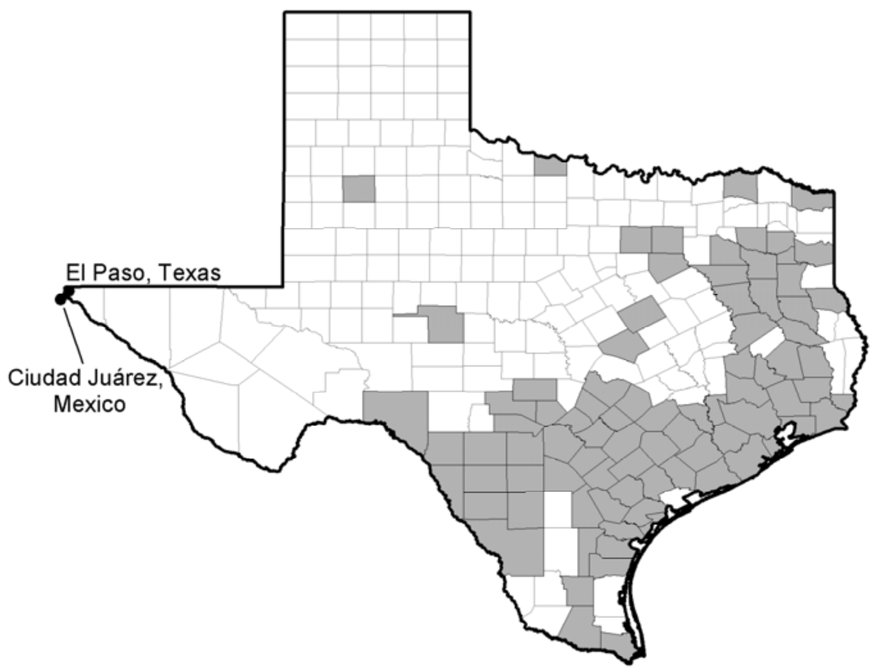
By all accounts, mosquito-borne disease is also not a significant problem in the Mexican section of Paso del Norte (Leyva 2001; Vilchis 2001a; Tarin 2001). No human cases of dengue

[8] Note, however, that dengue, like most infectious diseases, is underreported. See Cortez-Florez (2001) and CDC (2001a).

or yellow fever have been reported in Ciudad Juárez (or the state of Chihuahua) in the past several years (Table 3).

Dengue is absent from Paso del Norte mainly because the two mosquito species that serve as the primary vectors of the disease—*Aedes Aegypti* and *Aedes Albopictus*—are not prevalent in the area. Since trapping studies began in 1995, neither species has been found in El Paso City-County (Figures 1 and 2). Monitoring efforts in Ciudad Juárez have also failed to find dengue- and encephalitis-carrying mosquitoes (*El Diario* 2001a; Tarin 2001; Vilchis 2001a).

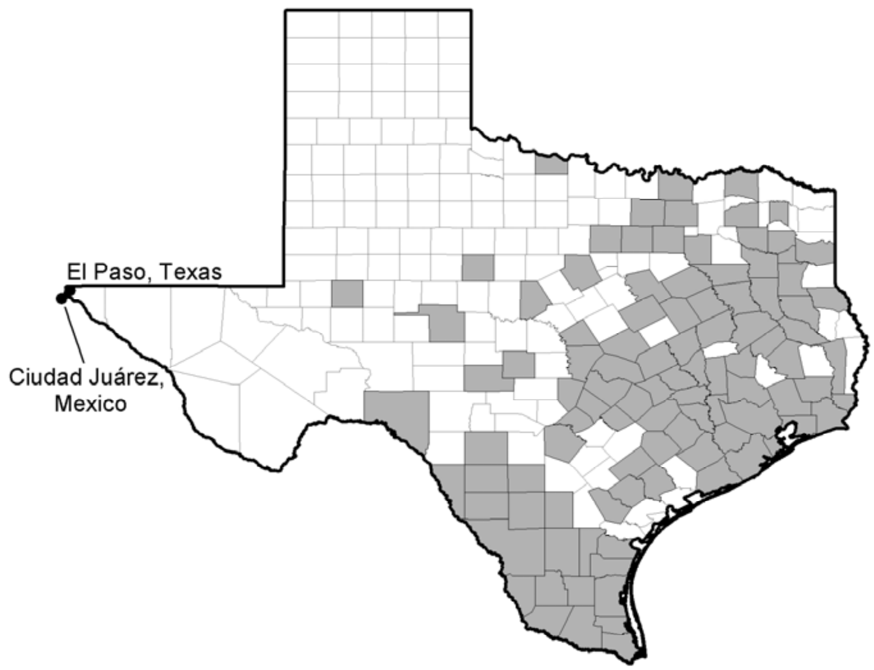
Figure 1. Texas Counties with *Aedes Albopictus* (1999)



(shaded areas = present)

(Source: Cortez-Florez 2001)

Figure 2. Texas Counties with *Aedes Aegypti* (1995)



(shaded areas = present)

(Source: Cortez-Florez 2001)

4. Scrap tires as solid waste

Disposing of whole scrap tires in conventional solid waste landfills creates a number of problems. Tires are bulky and take up considerable space. In addition, they tend to trap gases and rise to the top of landfills after being buried. As a result, laws in both Mexico and the United States prohibit landfilling tires along with other types of waste. Thirty-eight American states, including the border states except New Mexico, ban whole tires from landfills (STMC 2002a; U.S. EPA 2001).[9] In Mexico, scrap tires are classified as a special type of solid waste *(residuo*

[9] Texas has banned whole tires from landfills since 1991, Arizona since 1992, and California since 1993 (U.S. EPA 2001).

sólido de manejo especial), to be handled separately from other types of wastes (Ramirez and Benitez 2000).

As discussed above, both El Paso and Ciudad Juárez have separate dedicated facilities for scrap tire disposal. Ciudad Juárez's one municipal landfill, the Rellena Sanitario, does not accept scrap tires, and neither do the five landfills that service El Paso. Hence, scrap tires do not contribute to shortages of space in local solid waste landfills.[10]

That said, segregating tires from other solid wastes has given rise to new solid waste management issues. From 1992 through 1997, scrap tire disposal in Texas was managed by the Texas Natural Resources Conservation Commission. The commission required tire "generators," such as tire dealers and automotive shops, to collect a $2 recycling fee for every new tire sold. The resulting Waste Tire Recycling Fund was used to collect scrap tires, subsidize the cleanup of tire piles, and reimburse facilities using TDF. However, the recycling fund program expired in 1997, and since then, waste tire management has been largely left to the private sector. Consumers pay a disposal fee to scrap tire generators, generators pay transporters to ship scrap tires to authorized end users, and end users charge transporters a "tipping fee" for accepting the scrap tires. In El Paso, tire generators currently charge consumers approximately $1.50 per tire and pay a tipping fee of approximately $1.25 per tire to the Tres Pesetas tire collection and transport facility (Forehand 2001; Martin 2001).

Unfortunately, notwithstanding this system, illegal dumping is common in El Paso—a consequence of many factors, including consumers' reluctance to pay disposal fees, the difficulty of enforcing antidumping laws, and the proliferation of "tire jockeys" who collect scrap tires for a fee and then dump them illegally. To combat this problem, the El Paso Tire Dealers Association offers a reward for used tires, and Tres Pesetas is required to accept up to eight tires per person per year without charge. But these programs have not been particularly effective, either because the system is not well known by the community or because the reward is insufficient (Martin 2001; STMC 2002b). Not surprisingly, illegal dumping is also a problem in Ciudad Juárez (*El Diario* 2001b).

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[10] With a capacity of 1,200 tons per day, the recently opened Relleno Sanitario includes modern environmental controls and is relatively well managed (Salmeron 2001; Millot 2001). El Paso has access to five landfills: two inside the city (the Clint and the McCombs facilities), two outside the city (the Fort Bliss and CSC facilities), and one (the Camino Real facility) outside Sunland Park, New Mexico (Balverde 2001).

5. Tire pile fires

Tire pile fires are exceptionally hazardous. Partly because of their high energy content—14,000 to 15,000 Btus per pound versus 8,000 to 12,000 Btus per pound for coal—tire piles burn intensely and are extremely difficult to extinguish. Applying water is often problematic because of the attendant water pollution, and the recommended course of action is sometimes to simply let the pile burn itself out (U.S. Fire Administration 1998). Tire piles can burn for months. For example, a fire in Tracy, California involving some 7 million tires burned for more than two years between 1998 and 2000 before finally being extinguished (Carlson 2000).

Tire fires generally have severe impacts on the air, water, and soil. When burned in the open, tires combust incompletely and emit both conventional air pollutants (including particulates, carbon monoxide, sulfur oxides, nitrogen oxides, and volatile organic compounds) and so-called hazardous air pollutants (including polynuclear aromatic hydrocarbons (PAHs), dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyles (PCBs) and heavy metals such as lead and arsenic). Tire fire air pollutants can cause short-term and long-term human health problems, including irritation of the skin, eyes, and mucous membranes; respiratory effects; depression of the central nervous system; and cancer. Tire fire emissions are estimated to be 16 times more mutagenic (toxic) than emissions from residential wood-burning fireplaces, and 13,000 times more mutagenic than emissions from coal-fired utilities with good efficiencies and add-on pollution controls (U.S. EPA 1997).

Tire fires also generate water pollution. The tires melt into a tarry oil that can seep into groundwater and run into surface water, especially if water is used to try to extinguish the fire. A standard automobile tire generates about 2 gallons of oil (STMC 2000). Finally, oil, ash, and residue from tire pile fires contaminate soils with heavy metals and other toxic substances. Remediation is generally difficult, and the sites of many tire fires have been designated as hazardous waste cleanup sites.

The costs of extinguishing tire fires and remediating the sites can be enormous. Table 5 presents data on the costs of the Environmental Protection Agency's response for large scrap tire fires in EPA Region 6 (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas) in the second half of the 1990s. Note that these figures omit costs to the private sector and to municipal and state institutions.

Table 5. Tire Fires in EPA Region VI
December 1995 through September 2000

Facility	Location	Cost of EPA response ($)
SPE Tire Disposal	Midolithian, TX	1,800,000
ERI	Stamford, TX	380,000
Mid-South	El Dorado, AZ	260,000
Gibson Recycling I	Atlanta, TX	123,000
J.C. Elliot Landfill	Corpus Cristi, TX	554,000
Madisonville Drum	Madisonville, TX	193,000
Los Ebanos	McAllen, TX	16,000
S.W. Processor	Socorro, NM	178,000
Gibson Recycling II	Atlanta, TX	60,000
Total		3,573,279

(Source: Banipal and Mullins 2001)

United States

In the United States, large tire pile fires are not uncommon. Although some are started by natural events (primarily lightning), most result from arson. Unfortunately, systematic national data on the frequency and magnitude of such fires are lacking (Zalosh 2001).[11] However, EPA estimated that there were at least 176 large tire fires in the United States between 1971 and 1996 (Banipal and Mullins 2001).

Paso del Norte

Although there is no record of a major tire pile fire in Paso del Norte, numerous small fires have involved scrap tires. Records of the Ciudad Juárez Fire Department indicate that from

[11] The National Fire Incidence Reporting System (NFIRS) has data on fires for the past 10 years including the fire's location, time of ignition, first object of ignition, duration, and the dollar costs of the damage inflicted. Unfortunately, NFIRS captures only 40% to 45% of all actual fires. In 2000, approximately 3,000 fires with tires as the first object of ignition were reported to NFIRS. This implies that there are approximately 7,000 such fires each year. The number of tire pile fires—as opposed to the number of fires with tires as the first object of ignition—is not known (Schaenman 2001).

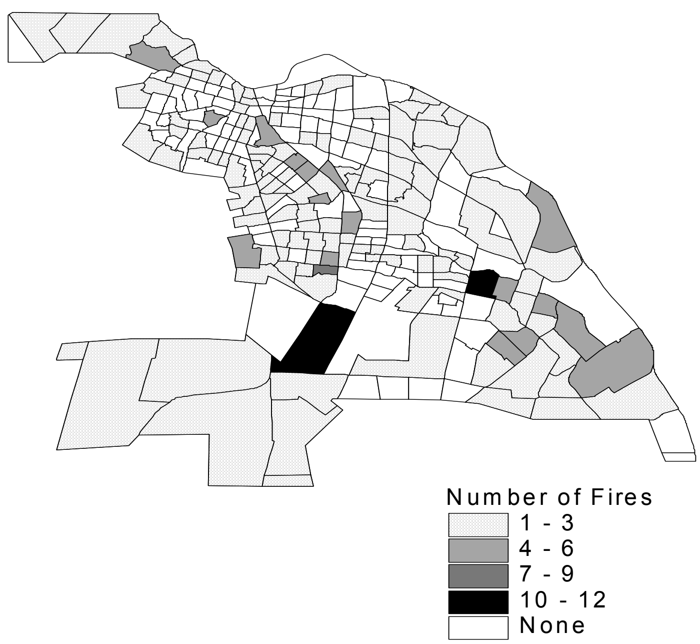
August 2000 through July 2001, there were 310 fires involving tires in the city, an average of 26 fires per month. The fires were more or less evenly distributed spatially (Figure 3) and across time (Table 6). Unfortunately, the number of tires in each fire is not known.

Table 6. Fires involving scrap tires in Ciudad Juárez
August 2000 – July 2001

Month	No. Fires
August	17
September	25
October	20
November	23
December	28
January	27
February	42
March	13
April	30
May	42
June	29
July	10

(Source: Ciudad Juárez Municipal Fire Department)

Figure 3. Fires Involving Scrap Tires in Ciudad Juárez
August 2000 – July 2001



(Source: Ciudad Juárez Municipal Fire Department)

Interviews indicate that Paso del Norte's environmental and public policy officials are concerned about the threat of a major tire pile fire, particularly the consequences for air quality (Figueroa 2001; Salmeron 2001; Velez 2001; Castillo 2001). Air quality in the metropolitan area is the worst on the U.S.–Mexico border. El Paso does not meet federal standards for three criteria air pollutants—carbon monoxide, particulate matter, and ozone—and conditions in Ciudad Juárez are at least as bad.[12] Stakeholders are less concerned about the risk of groundwater contamination from tire fires because Paso del Norte's groundwater is approximately 70 to 90 meters underground, at least twice the depth at which significant contamination from runoff could be expected (Nuñez 2001; Diaz 2001).

[12] Criteria air pollutants are those for which the U.S. Environmental Protection Agency has established an ambient standard to protect human health and welfare. National ambient standards are in place for ozone, carbon monoxide, particulate matter, nitrogen oxides, sulfur oxides, and lead.

6. Tire-derived fuel

Although tires burned in the open combust incompletely and emit a variety of highly toxic substances, they are not nearly so polluting when burned at high temperatures in industrial combustors, such as boilers and kilns. An EPA laboratory study concluded that "with the exception of zinc, potential emissions from TDF are not expected to be very much different than from other conventional fossil fuels as long as combustion occurs in a well-designed, well-operated and well-maintained combustion device." (p. ix) Furthermore, EPA found that a sample of 22 industrial facilities using TDF to supplement their normal fuels were still able to satisfy regulatory emissions standards (U.S. EPA 1997).[13] Nevertheless, TDF generates controversy, and some environmental advocates and citizens' organizations oppose it (TDF Workshop 2001).

Country-level data on TDF use are available for the United States but not for Mexico. In the United States, TDF use has grown dramatically over the past decade. In 1990, only 2 American plants, both cement manufacturers, were using the fuel. By the end of 2001, 82 plants were burning 115 million scrap tires each year. Of those 82 plants, 36 were cement kilns, 18 were pulp and paper mills, 17 were industrial boilers, and 11 were electric utilities (STMC 2002a). The rapid adoption of TDF in the United States may well spill over into Paso del Norte.

Currently, TDF is being used for only one industrial activity in Paso del Norte—traditional brickmaking in Ciudad Juárez. Numbering roughly 400, Juárez's rudimentary adobe kilns are small-scale, low-technology, and highly polluting. They clearly do not fall into the category of the "well-designed, well-operated and well-maintained" combustors described in the EPA study. Each kiln employs an average of six workers, is fired twice a month, and uses a variety of cheap, dirty fuels. The vast majority of brickmakers do not use any emissions control devices (Blackman and Bannister 1997). Since the early 1990s, Mexican regulators have strictly prohibited firing brick kilns with TDF. Nevertheless, enforcing these prohibitions is difficult, and some brickmakers continue to burn tires surreptitiously. However, the quantities involved are relatively insignificant. Collectively, brick kilns in Ciudad Juárez probably burn no more than 500 tires per year (Marquez 2001).

[13] However, the EPA study also noted that particulate control devices would likely be needed before a permit for TDF could be issued in most jurisdictions. In addition, it noted that either preprocessing of scrap tires (dewiring and shredding) or specially designed feeder systems for whole tires are typically needed to use TDF in conventional combustors (EPA 1997).

Although TDF is not common in Paso del Norte, there is considerable interest in adopting the fuel. On the Mexican side, there are several cement plants in the state of Chihuahua—including one in Ciudad Juárez—that could burn Paso del Norte's scrap tires (Marquez 2001; I. Ortega 2001). According to a feasibility study conducted by the Ciudad Juárez plant, TDF would be an attractive and cost-effective alternative to coal as long as (1) a steady supply of scrap tires can be found within 300 km of the plant, and (2) the plant is paid the tipping fee currently being charged for scrap tires (Gonzales 2001).

The most likely adopter of TDF on the American side of the border is an electric power utility in El Paso. The utility is considering building a small (2 MW) peaking plant that will use TDF exclusively in a low-emissions "starved air" combustor.[14] Costing $6.5 million to $7.5 million, the plant would consume 100,000 tires a month, or 1.2 million tires a year. The primary supplier of tires would be Tres Pesetas, El Paso's scrap tire management company. The feasibility study for the project assumes that the electric utility would neither pay for the tires nor be paid for accepting them (Ito 2001; Rodrigue 2001).

Opportunities for using TDF in American cement plants in the vicinity of Paso del Norte are limited. The closest plant is in Odessa, about 300 miles away, and next closest is in Dallas, about 650 miles away. As noted in Section 2, the Odessa plant already uses tires from Tres Pesetas. However, the amounts involved are small—less than 10% of the facility's annual supply (Perry 2001). Transportation costs probably make it impractical to use Paso del Norte tires in the Dallas plant (Chacon 2001).

There are two obstacles to the quick adoption of TDF in Paso del Norte. First, the supply of scrap tires in the area will support only one TDF project. It might also support some small-scale end uses, such as crumb rubber, but markets for these products are not yet well developed (Chacon 2001; Rodrigue 2001; Perry 2001; Gonzales 2001). Second, there are bureaucratic obstacles to cross-border cooperation on TDF, as evidenced by problems encountered in the course of efforts to mitigate binational pollution and water scarcity problems.[15] Such bureaucratic obstacles might prevent a plant on either side of the border from using TDF from the other side.

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[14] Commonly used in waste incinerators, starved-air processes limit the amount of air available for combustion. The end result is reduced levels of such pollutants as sulfur dioxide and nitrogen oxides.

[15] For a discussion of cross-border environmental management, see Kiy and Wirth (1998).

7. Conclusion

To summarize, we found that Paso del Norte probably has at least as many scrap tires as any other metropolitan area on the U.S.–Mexico border. The bulk of the problem is on the Mexican side of the border: Ciudad Juárez probably has 100 times as many scrap tires as its sister city, El Paso. The disparity in the stocks of scrap tires in the two cities arises partly because El Paso's private-sector scrap tire management facility has found end uses for its stocks, while Ciudad Juárez's public-sector facility has not. Perhaps just as important, there is a steady cross-border flow of American scrap tires into Ciudad Juárez.

Of the health and environmental risks traditionally linked to scrap tires, neither the propagation of mosquito-borne diseases nor the contribution of scrap tires to shortages of space in solid waste disposal sites appears to be important in Paso del Norte. The two mosquito species that carry dengue—the most serious mosquito-borne disease globally—are not found in the central portion of the U.S.–Mexico border. Also, Paso del Norte has thus far been spared outbreaks of other mosquito-borne diseases, such as encephalitis, malaria, and yellow fever. Scrap tires do not overburden solid waste disposal sites in Paso del Norte because both Ciudad Juárez and El Paso segregate scrap tires from other solid wastes. However, illegal dumping continues to be a significant problem in both cities, particularly in Ciudad Juárez, where illegal piles may contain millions of scrap tires.

Tire pile fires, by contrast, pose a significant threat to human health and the environment in Paso del Norte. Mainly the result of arson, such fires are notoriously difficult to extinguish and generate highly toxic air and water pollution. Clearly, a fire at Ciudad Juárez's secured disposal facility—the largest tire pile in Paso del Norte by an order of magnitude—would generate the greatest damages. But presumably, this threat is mitigated by fact that this site is secured and relatively well managed. Therefore, the greatest threat may be a fire at one of Ciudad Juárez's smaller, unsecured tire piles. Fortunately, groundwater is at a sufficient depth to be safe from contamination in case of a major tire fire.

Finally, the threat posed by the industrial use of scrap tires for fuel in Paso del Norte is indeterminate. Currently, only small-scale traditional brick kilns in Ciudad Juárez are using TDF. However, this activity is illegal, and the quantities involved are probably insignificant. At least two large-scale facilities are contemplating using TDF in the near future: an electric power generator in El Paso and a cement plant in Ciudad Juárez. The former would be subject to stringent pollution control regulations and would use various pollution control technologies, so environmental impacts would almost certainly be minimal.

The impact of a Ciudad Juárez industrial facility adopting TDF is less certain. If the plant's kilns are well designed and well maintained and if the plant's current fuel is relatively dirty, then the marginal environmental impact of adopting TDF might be minimal. Also, adopting TDF would shrink existing scrap tire piles. Indeed, if demand for TDF were strong enough, both secured *and* unsecured piles would be mined for fuel. In any case, shrinking tires piles would reduce the risk of a large tire pile fire, which would almost certainly be far more damaging to human health and the environment than controlled burning at an industrial facility, even one with minimal air pollution abatement devices. Finally, if demand were strong enough, adopting TDF could reduce illegal dumping of scrap tires.

Thus, of the various health and environmental impacts commonly associated with scrap tires, the most important in Paso del Norte is probably the risk of air pollution from a large tire pile fire. Unfortunately, the risk of such fires is probably greatest at unsecured tire piles, so efforts to mitigate this risk will have to include ways of shrinking these piles. One strategy for achieving this goal is to promote markets for scrap tires, which in turn create incentives for the private sector both to mine existing informal sites and to avoid establishing new ones. This strategy may become easier to pursue as scrap tires are increasingly seen as sources of energy and raw materials rather than as a particularly dangerous and troublesome type of solid waste.

Finally, what are the broader implications of this case study? We found that many of the health and environmental risks conventionally linked to scrap tires—including the propagation of mosquito-borne diseases, groundwater pollution from tire fires, air pollution from industrial use of TDF, and shortages of space in solid waste disposal sites—are *not* significant in Paso del Norte. Local geophysical and institutional conditions clearly affect the types and magnitudes of the risks scrap tires generate. As a result, generalizing about these risks can be misleading. Case-by-case analysis is needed to determine which risks are important and what mitigation policies are appropriate.

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